Space Weather Technical Forecast

Issued on Sunday, 10 July 2022 at 13:14 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Daily Chance of further M-class flares and R1/R2 Radio Blackouts. One CME pending analysis.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is Low, with a few C-class flares recorded at GOES16, peaking with a C8.5 at 09/1348UTC. This emanated from a plage region on the southwestern limb, most likely that containing the remnant of AR3047, which presented as a Zurich Bxi at peak some days ago as it crossed the facing side. This was associated with a large non-Earth directed Coronal Mass Ejection (CME). Also of note was an impulsive C5.1 at 09/2103UTC, with this emanating from the trailing portion of previously quiet sunspot group AR3051 in the northwestern quadrant. Finally, a third event in the form of a long-period C4.6 was observed at 09/2245UTC from immediately east of AR3052 and a CME was probably generated, although imagery remains limited. Being near the solar meridian, an Earth-directed component is probable.
There are six sunspot regions on the disc in total, with the two largest and most complex both occupying the eastern solar hemisphere. There are two large regions AR3053 and AR3055 and AR3053 showed proliferation in its intermediate spots and some spreading as an Eki/Beta-gamma and gave rise to an M2.5 flare and non-Earth-directed CME prior to this reporting period at 08/2048UTC. To its southeast, AR3055, while smaller, showed more change overall, with central spot development, areal growth and spreading all contributing to an eventual class of Ekc/Beta, although no significant flare activity was recorded. The remaining sunspot groups appear unremarkable but have recently given rise to a few C-class flares.
There are currently numerous large filaments on the Sun, with the southeast quadrant in particular harbouring two large features that each span roughly 20 degrees on the solar disc. There were no signs on instability in these in the reporting period, however they will become increasingly relevant should they lift off in the coming few days, and will be monitored.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, remained slow-ambient, with a probable SSBC observed at the end of the period, with the phi angle mostly orientated in a weakly positive direction (away from the sun). The solar wind density was near Average. The IMF showed a rising trend towards the end of the period, reaching above 10nT by 10/100UTC, with the north-south component ranging between +7 and -8nT. The net result of the above solar wind measures was Quiet for much of the 24 hours, peaking at a provisional Kp of 3- in the 12-15UTC window.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16, showed a response in the lower end of the spectrum in the wake of the C8.5 flare from the limb, with greater than 10MeV rising to a peak of nearly 5pfu at 09/1805UTC. The harder end of the spectrum was relatively unresponsive to the same stimulus.
The high energy electron flux (greater than 2MeV) remained at Normal Background levels. The corresponding 24-hour integrated electron fluence remained well below the Active (1e8 integrated pfu) threshold on a roughly level trend. Observed fluence was 1.62e6 integrated pfu

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at 10/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to remain Low, but with a daily Chance of M-class flares. A progressive slight increase is possible in the four days, with the sunspots that present the greatest risk of flares still in the eastern solar hemisphere, possibly bolstered by further arrivals over the northeastern limb into the new working week UTC.

Solar Wind / Geomagnetic Activity: A glancing blow from a CME may affect on day 2 (11 July) with low confidence and there may be another more prominent CME arriving at Earth towards the end of the period.
Solar winds starting slow-ambient. Recent STEREO A measurements suggest effects from CH99/+ may present at Earth from Monday 11 July, albeit with low confidence for bearing little resemblance to last rotation and possessing a very fragmented leading edge. All considered, there is a Slight Chance of a G1/Minor Storm at this time, reducing to more reliably Quiet levels once again towards midweek.

Energetic Particles / Solar Radiation: In the absence of any significant sunspot development, the high energy proton flux (greater than 10 MeV) is likely to remain at Background levels. There is a daily Slight Chance of S1 or greater, with risks from the southwest limb feature bolstered by the westward progression of the front-sided large sunspot groups.

The high energy electron flux (greater than 2MeV) may increase at the end of this period, but the corresponding fluence is Likely to remain well below the Active threshold (1e8 integrated pfu).

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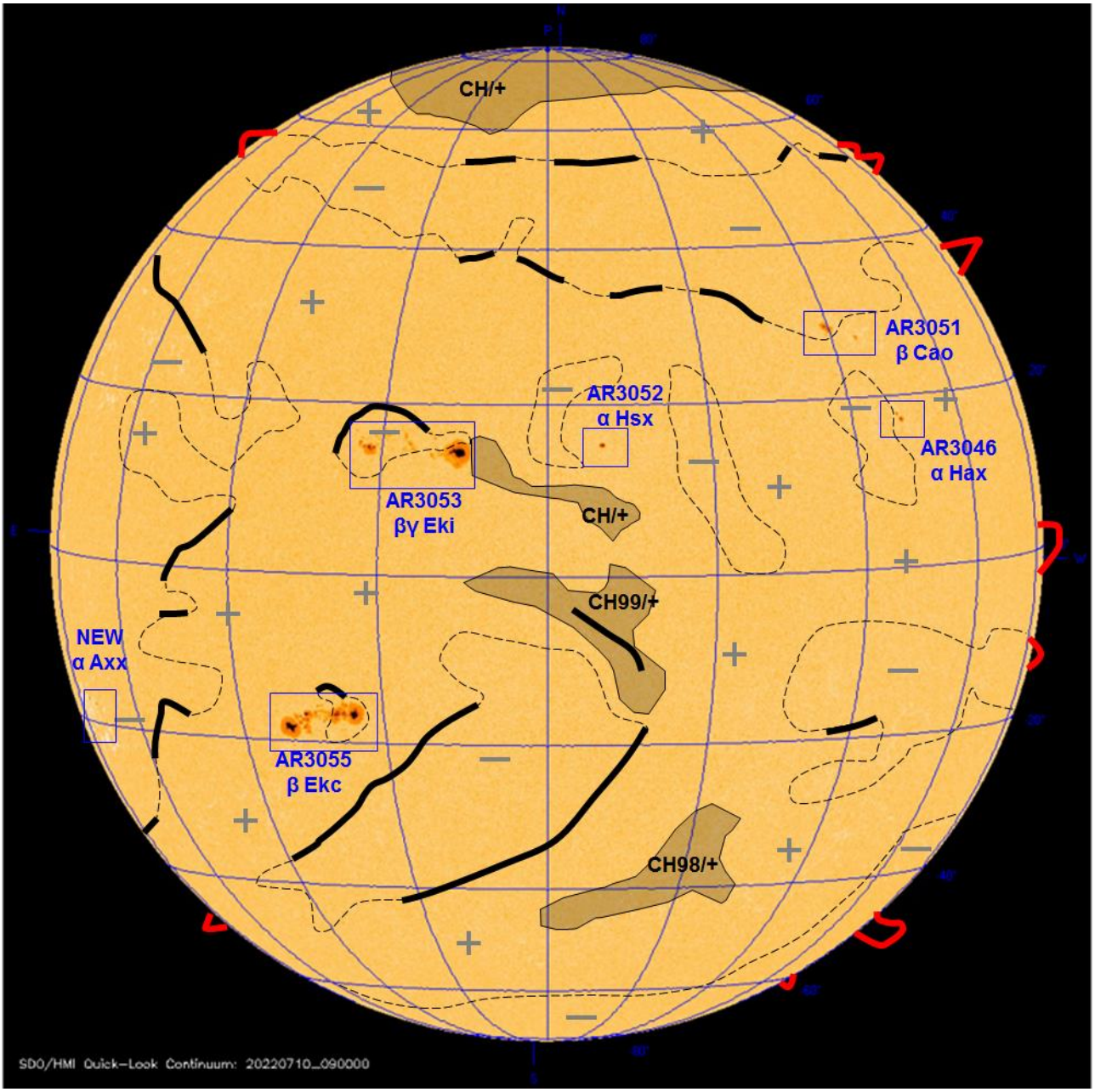
Figure 1. Solar Analysis Valid 0800UTC, 10 July 2022.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The solar wind is at slow-ambient levels, and the next coronal hole worth of note is the very fragmented CH99/+. This is a recurring feature that generated speeds of 600km/s on the previous rotation, however, due to its smaller size and fragmentation in the intervening month, it is hard to envisage similar will be achieved this time around.

STEREO A does show an analogous enhancement in recent hours associated with a positive phi angle, which would correlate to an arrival at Earth on Monday 11 July which would be 24 hours earlier than expected versus SWPM. Some additional influence is possible from CH98/+ by midweek, although any distinction is not likely to be possible given the identical phi angle. Geomagnetic activity will likely be at Quiet to Unsettled levels with a Slight Chance of a G1/Minor Storm, especially on Monday 11 July and again more likely later in the period if the CME interacts with Earth from the C4 flare that left the sun late on 9 July.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	20	10	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
09/0047	Partial?	AR3053	NE quadrant	1072	11/1800	SWPC ENLIL has CME more likely to affect Earth and a little earlier. Met Office ENLIL indicates a miss with later arrival.

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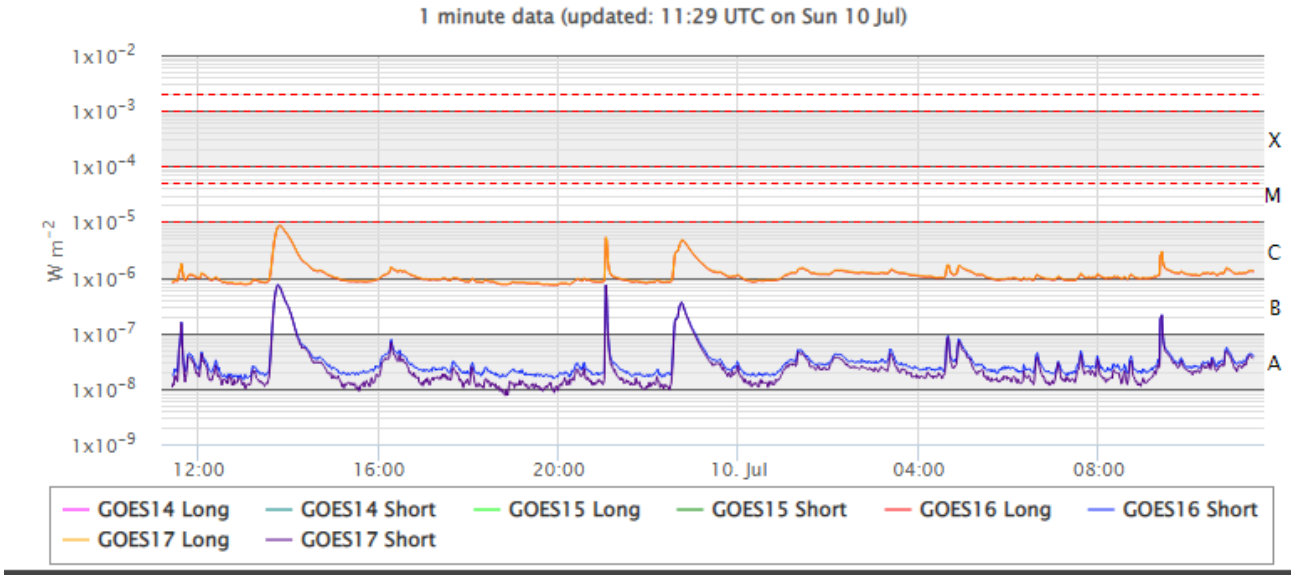
Radio Blackouts - X-Ray Flares:
There are currently five numbered sunspot regions on the visible disc and one unnumbered, with the risks of significant flares dominated by a pair of Zurich E-groups in the eastern solar hemisphere. AR3055 has shown a degree of growth in recent hours. Both regions are perhaps slightly under-active for their class on paper. Despite this, there is felt to be a daily Chance (40-50%) of further M-class flares. Regarding trends, neither of the two large sunspot regions depart the Earth-facing side in the four-day period, while there is some evidence of further arrivals over the eastern solar horizon. Bright flux regions are visible in EUVI195 in the northeast, with these likely to progressively cross onto the disc into the new working week UTC, although the degree to which these affect the flare forecast remains to be seen.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	40	40
Very Active	R3 to R5 X Class	No	15	15	10	10

Figure 2: X-ray flux plot at GEO with several C-class flares



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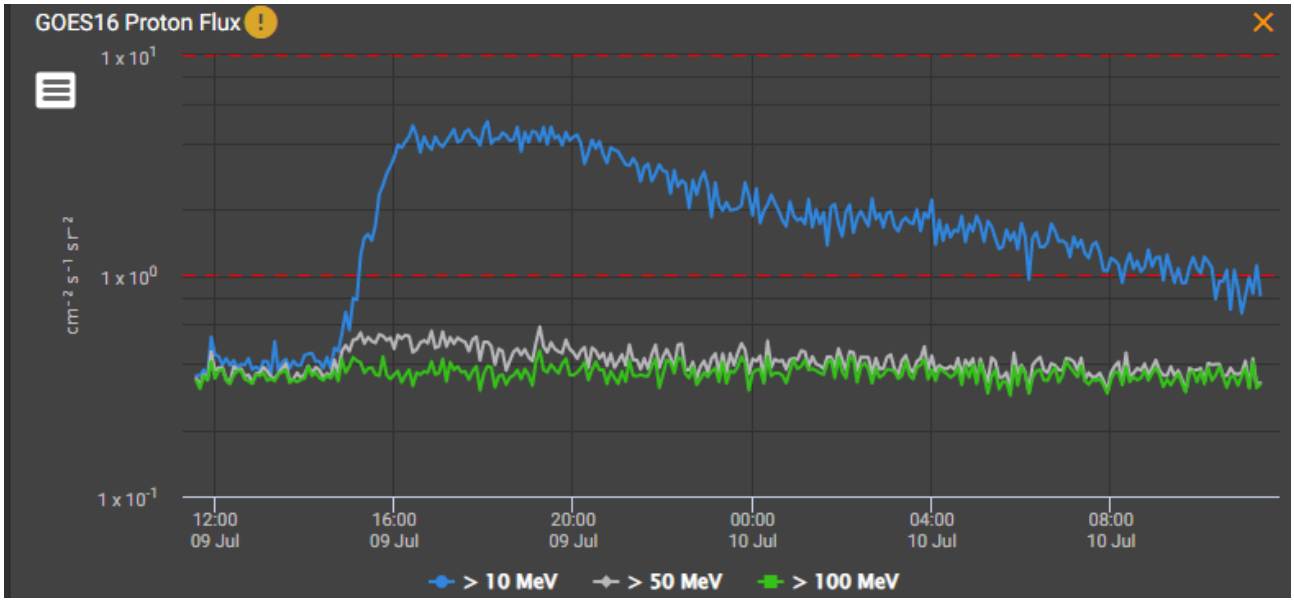
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) is currently slightly elevated at the low energy end of the spectrum in response to the C8.5 flare from Ex-3047. Flux levels are therefore starting from a slightly higher baseline should any further events occur from the limb or one of the large front-sided sunspot groups - most of the latter being in the eastern solar hemisphere at present. All considered, there is a slightly greater risk of S1 in the four days relative to previous guidance, with the upward tendency in risk perhaps approaching 10% towards midweek.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 3: GOES 16 proton Flux showing recent enhancement in levels over past 24 hours.



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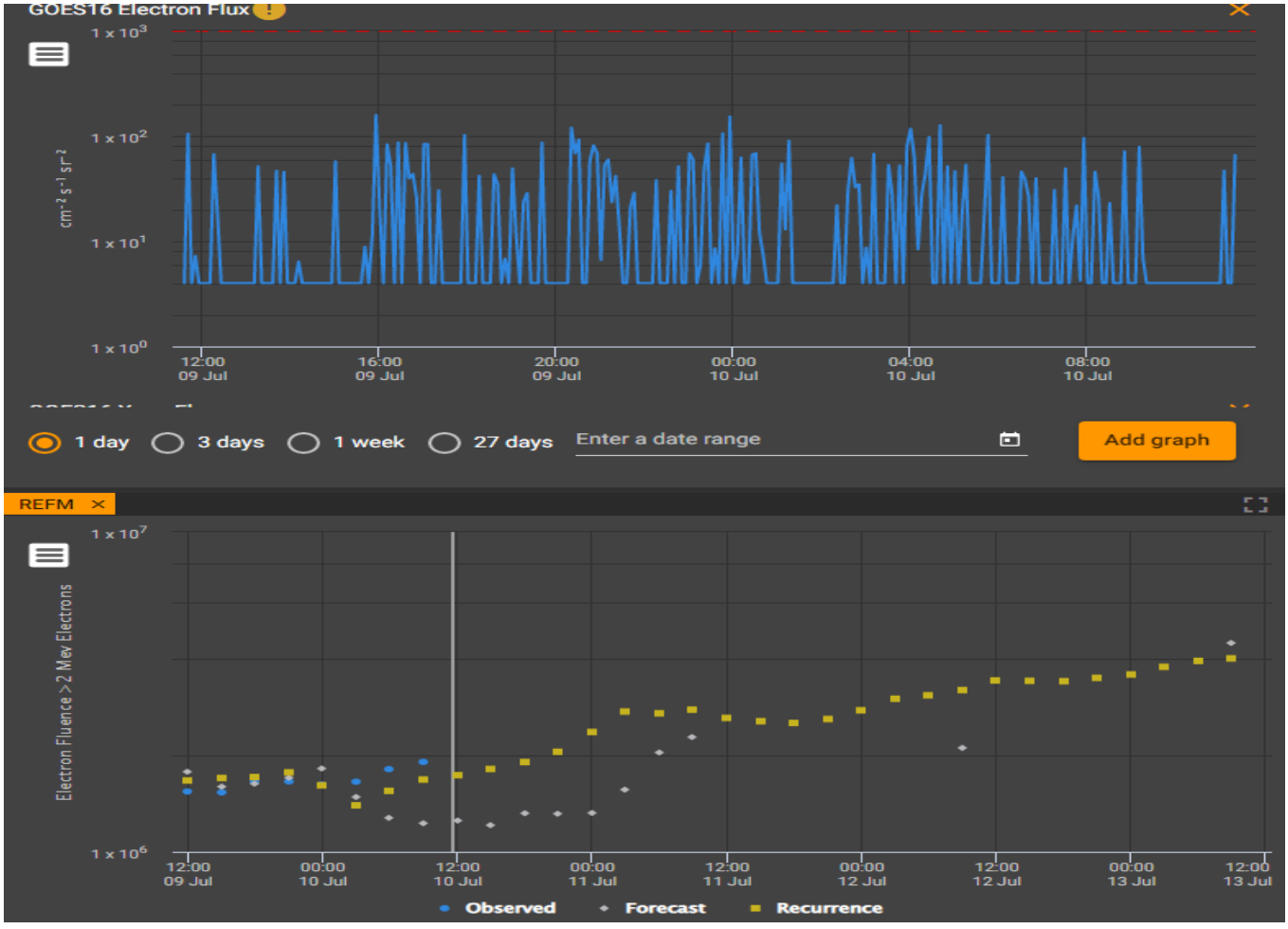
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) is currently at Normal Background levels, and the diurnal pattern in response to CH97/+ now ought to be apparent, i.e. current flux levels are probably already the peak for this feature. While CH99/+ is a persistent feature, it is much-changed in comparison with the previous rotation, and as such confidence is relatively low. 600km/s fast winds and a Slight Chance of G1 ought to make an impression in flux levels, with these rising to a new equilibrium before midweek UTC, albeit most likely comfortably short of 24-hour integrated Active fluence levels.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	10	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: High energy electron flux at GEO and Met Office REFM output.



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